THE SPECTRUM OF URANUS *

IN the paper "On the Spectra of some of the Fixed Stars,"† presented conjointly by Dr. Miller and myself to the Royal Society in 1864, we gave the results of our observations of the spectra of the planets Venus, Mars, Jupiter, and Saturn; but we found the light from Uranus and Neptune too faint to be satisfactorily examined with the spectroscope.

By means of the equatorial refractor of 15 inches aperture, by Messrs. Grubb and Son, recently placed in my hands by the Royal Society, I have succeeded in making the observations described in this paper of the remarkable spectrum afforded by the light of the planet Uranus.

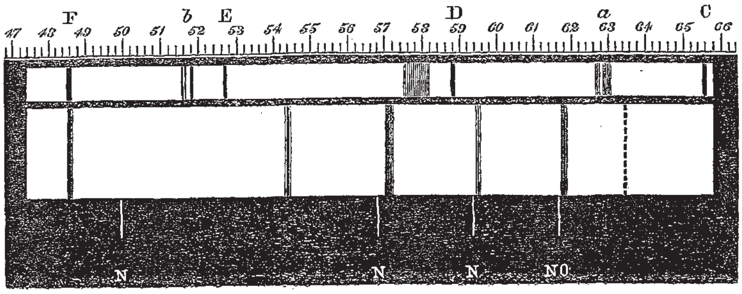
It should be stated that the spectrum of Uranus was observed by Father Secchi in 1869.‡ He says, "Le jaune y fait complétement défaut. Dans le vert et dans le bleu il y a deux raies très larges et très noires." He represents the band in the blue as less refrangible than F, and the one in the green as near E.

The spectrum of Uranus, as it appears in my instrument, is represented in the accompanying diagram. The narrow spectrum placed above that of Uranus gives the relative positions of the principal solar lines, and of the two strongest absorption-bands produced by our atmosphere, namely, the group of lines a little more refrangible than D, and the group which occurs about midway from C to D. The scale placed above gives wave-lengths in millionths of a millimetre.

The spectrum of Uranus is continuous, without any part being wanting, as far as the feebleness of its light permits it to be traced, which is from C to about G.

On account of the small amount of light received from this planet, I was not able to use a slit sufficiently narrow to bring out the Fraunhofer lines. The positions of the bands produced by planetary absorption, which are broad and strong in comparison with the solar lines, were determined by the micrometer and by direct comparison with the spectra of terrestrial substances.

The spectroscope was furnished with one prism of dense flint-glass, having a refracting angle of 60°, an observing telescope magnifying 5½ diameters, and a collimator of 5 inches focal length. A cylindrical lens was used to increase the breadth of the spectrum.



The remarkable absorption taking place at Uranus shows itself in six strong lines, which are drawn in the diagram. The least refrangible of these lines occurs in a faint part of the spectrum, and could not be measured. Its position was estimated only, and on this account it is represented in the diagram by a dotted line. The positions of the other lines were obtained by micrometrical measures on different nights. The strongest of the lines is that which has a wave length of about 544 millionths of a millimetre. The band at 572 of the scale is nearly as broad but not so dark; the one a little less refrangible than D is narrower than the others.

The measures taken of the most refrangible band showed that it was at, or very near, the position of F in the solar spectrum. The light from a tube containing rarefied hydrogen, rendered luminous by the induction-spark, was then compared directly with that of Uranus. The band in the planet's spectrum appeared to be coincident with the bright line of hydrogen.

Three of the bands were shown by the micrometer not to differ greatly in position from some of the bright lines of the spectrum of air. A direct comparison was made when the principal bright lines were found to have the positions, relatively to the lines of planetary absorption, which are shown in the diagram. The band which has a wave-length of about 572 millionths of a millimetre is less refrangible than the double line of nitrogen which occurs near it. The two planetary bands at 595 and 618 of the scale appeared very nearly coincident with bright lines of air. The faintness of the planet's spectrum did not admit of certainty on this point; I suspected that the planetary lines are in a small degree less refrangible. There is no strong line in the spectrum of Uranus in the position of the strongest of the lines of air, namely, the double line of nitrogen.

As carbonic acid gas might be considered, without much improbability, to be a constituent of the atmosphere of Uranus, I took measures with the same spectroscope of the principal group of bright lines which present themselves when the induction-spark is passed through this gas. The result was to show that the bands of Uranus cannot be ascribed to the absorption of this gas.

There is no absorption-band at the position of the line of sodium. It will be seen by a reference to the diagram that there are no lines in the spectrum of Uranus at the positions of the principal groups produced by the absorption of the earth's atmosphere.

WILLIAM HUGGINS

NOTES

WE understand that the contributors to the next volume of the *Zoological Record* are as follows:—Mammalia, Reptilia, and Pisces, Dr. Albert Günther, F.R.S.; Aves, Mr. H. E. Dresser, F.Z.S., and Mr. R. B. Sharpe, F.L.S.; Mollusca, Molluscoidea, and Crustacea, Dr. Edward von Martens, F.M.Z.S.; Arachnida and Myriapoda, Mr. O. Pickard-Cambridge, C.M.Z.S.; Insecta generally and Coleoptera, Mr. E. C. Rye; Lepidoptera, Mr. W. F. Kirby; Diptera, G. A. Verrall; Neuroptera and Orthoptera, Mr. M'Lachlan; Rhynchota, Mr. John Scott; Vermes, Mr. E. Ray Lankester; Echinodermata, Cœlenterata, and Protozoa, Prof. Traquair. Respecting the work and the association which has been formed to prosecute it, we spoke at some length a few weeks ago, and will only remind our readers that the secretary of the Zoological Record Association is Mr. H. T. Stainton, F.R.S., to whom all applications for further information on the subject should be addressed.

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* From the Proceedings of the Royal Society.

† Phil. Trans. 1864, p. 413; and for Mars, Monthly Notices R. Ast. Soc. vol. xxvii., p. 178.

‡ Comptes Rendus, vol. lxviii, p. 761, and "Le Soleil," Paris, 1870, p. 354.

We are glad to see that the higher examination for women at the University of London has this year been successfully taken by one candidate in the department of Natural Philosophy and Chemistry. She is from the Cheltenham Ladies' College.

We have received the Anniversary Address of Sir Roderick Murchison, as retiring President of the Royal Geographical Society, dealing with the history of geographical progress during the past year.

A letter has been received from Dr. Hooker from Mogadore, bringing down the narrative of his journey to April 26. The party had visited Ceuta, Gibraltar, and Casa Blanca, but had found no very striking novelties since the last report.

Mr. Thomas Moore, the Curator of the Chelsea Botanic Gardens, is now delivering in the gardens a course of six lectures on Botany for medical students.

A scientific society has been formed at Middletown, Connecticut, and Dr. John Johnson, of the university, elected president, Prof. Rice, corresponding secretary, and Prof. John M. Van Vleck, treasurer.

Prof. Newton of Cambridge is engaged upon a revised edition of Yarrell's well-known "History of British Birds," which has long been justly regarded as the standard work on the ornithology of these islands. It is now more than thirty years ago since the late Mr. Yarrell began the first edition of this book, and as the literature of the subject has in that time been doubled if not trebled, the editor will have enough to do to bring the work up to the level of the information of the present day. It is announced that the mode of publication will be in monthly numbers, the first of which may be expected in the course of a few days.

At a recent meeting of the Asiatic Society of Bengal, Col. Strachey made a communication to the effect that the Government of India have lately resolved to place four lacs of rupees in deposit, which sum should be available for completing the new Museum building at Calcutta. He regretted the delay which has been caused in the construction of the building, and stated that it was greatly due to the financial difficulty in which the Government of India found themselves a short time ago. Col. Strachey mentioned that the original approximate estimate amounted to about three and a half lacs of rupees. This sum had been sanctioned by Government, and the work for the new building was commenced. Subsequently the regular estimate came up, and it amounted to about seven lacs. After about four lacs had already been spent, a revised estimate was called for, and this rose to about ten lacs. It was, therefore, not surprising that the Government stepped in and inquired into the whole matter carefully, and this caused such a delay that it became impossible to complete the Museum within the appointed time, 23rd March, 1871. However, Col. Strachey hoped that the present action taken by Government in the matter would bring the building to its desired completion at as early a date as possible.

At Plymouth, one of the largest provincial centres of science instruction in connection with the South Kensington department, this year's examinations have just been brought to a close, the arrangements having been carried out under the direction of the School Board for the town, in compliance with the request of the department in their circular of March 7th. In accordance with it the School Board appointed their clerk, Mr. Henry Soltan, as the examination secretary, and the assistants were selected principally from the secretaries of the various Science and Art Schools of the town. These gentlemen have been occupied every evening during last month, up to Monday last (22nd), in superintending the conduct of the various examinations which have all been held at the Public Free School, and which have comprised no less than twenty-two subjects in science, besides the four branches of art study, of the second grade, the examinations in which in previous years have been held in March. The details show that a total of 846 papers has been worked, 257 in Art and 589 in Science. The largest numbers of papers in any special subjects were Physical Geography 151, and Freehand Drawing, and Mathematics, stages 1, 2, and 3, each 112.

A considerable portion of modern astronomical literature appears to be designed to bring science into contempt. A paper has been circulated, containing an "extract from a letter addressed to John Hampden, Esq., Chippenham, Wilts," attributing the death of Sir John Herschel to "the chagrin he has for some time evinced at the severe attacks recently made on the astronomical theories with which his name has been so long and prominently associated." It is only the most uncleanly of animals that howl around the bodies of the dead; we should have thought that any "gentleman" receiving such a letter would have consigned it at once to the fire instead of sowing it broadcast over the land.

The Scotch papers report a mirage at the mouth of the Forth on Sunday the 21st inst. The weather was remarkably warm, and in the afternoon there was a dull deceptive haze. The sea presented almost the appearance of a mirror, and the vessels upon it seemed to have a double reflection from the sea and the background beyond. At one time the masts and rigging seemed elongated to four or five times their natural length, and then in the course of a few minutes they were reduced so as to be scarcely visible. At other times the vessels appeared to be sailing double—one ship in sea and one in air. Extraordinary appearances were assumed by the May Island, which rose and fell and changed to all manner of shapes in the course of a few minutes. At one time it appeared a perpendicular wall, rising to the height of several hundred feet, and shortly afterwards it appeared to be flat on the surface of the sea. All the other objects which came within the range of the refraction underwent similar changes, and the illusion lasted with varying features for several hours.

Dr. Marshall Hall has contributed to the *Devizes Gazette* a letter, calling attention to the importance, at the present time, of establishing local centres for instruction of farmers in agricultural chemistry and sciences connected therewith. In connection with the circular of Mr. Little's, printed last week, we hope the subject is now at length attracting the attention it deserves.

The *Engineer* of last week contains a drawing of the machinery used in the casting of the Vendôme Column, lately thrown down by the Paris Communists.

At Derajat, in India, a supply of water has been obtained by artesian boring at the depth of 400 feet.

"To the Rt. Hon. Earl Granville, K.G., H.M.'s Secretary of State for Foreign Affairs," &c., &c. Suppose there were addressed to his Lordship a rather pressing letter from the Anthropological Society of Honolulu or Bolivia, requesting him to furnish male and female skulls of each of the tribes of Irish, Welsh, Erse, Lowlanders, Danes, English, &c., inhabiting these islands; a special application made for skulls from St. Giles's, and the Liberties of Dublin; skulls of extinct tribes earnestly sought; and his Lordship expected to supply a consignment of 200 or 300 skulls, besides their flint and other implements, tobacco pipes, pottery, and so forth, ancient and modern. What would be the commotion here, and what the comments in our newspapers! and yet such a request has been made by the zealous Secretary of the Smithsonian Institute to the Government of the United States of Colombia, and he is likely to prefer the same hint here, now that the *Alabama* claims are in happy way of settlement. The Colombian Government has taken the matter coolly, and published the application in the *Gaceta Oficial*, calling to it the attention of the local authorities. How the local authorities will persuade the local Indians to hand over the solicited pair of recent male and female skulls, appears rather doubtful and dangerous, as will be the polite request of the resident magistrate, or other authority, to the tribes of Achill Island or Connemara. Some of the Indian tribes in Colombia are much more likely to place the skulls of the Government or their emissaries in their own local museums.

IT is stated from India that a number of experiments have shown that the madar plant, when mixed with opium, is an excellent substitute for ipecacuanha in dysentery.

THE Kava or Ava is well known as a favourite intoxicating drink of the South Sea Islanders. The extraordinary and disgusting mode of preparing this beverage, by chewing the root, ejecting the saliva into a bowl and fermenting it, has been the means of giving it a greater amount of publicity than it would have otherwise obtained. Many stories have been told about its uses and effects. It appears that at one time before the intercourse with foreigners the only intoxicating drink known to the natives was the water in which the roots of the kava plant (*Macropiper methysticum*) had been macerated, and this was comparatively little used, except as a medicine, as it was supposed to prevent corpulence. Since the introduction of foreign spirits into the islands the use of kava has much diminished, though intoxication is none the less common, and with many of the natives kava is still much appreciated, and even many of the lower classes of white people are confirmed kava-drinkers. It is said that, if drunk in excessive quantities, it produces numerous cutaneous diseases, but if taken in moderation has no ill effect upon the system. A drink, prepared in a similar filthy manner, is the South American Piwarri, which is produced by first chewing a sufficient quantity of cakes made of cassava meal (*Manihot utilissima*), and then putting the masticated material into a bowl with water, where it is left to ferment for some days, and finally boiled.

So much has been said about the adulteration of butter and the frequent substitute of a compound for that useful article, in which no trace of true butter exists, that the introduction of Australian butter into this country is a matter not only of commercial importance, but must also give general satisfaction to all classes. The butter is of good quality, and arrives after its lengthened voyage in good condition. It is produced in different parts of the Australian colony, so that we may hope to receive large and continuous supplies. It is a fact worth noting that whereas at one time large supplies of butter were exported from Cork into the colonies, one of these same colonies is now sending its produce to us.

THE cultivation of the beet in England for the manufacture of sugar seems in a fair way of at last becoming a *fait accompli*. Besides the works already in operation at Lavenham in Suffolk, Buscote in Berkshire, and other places, a new beetroot sugar company has just been formed under good prospects at Sandwich in Kent.

PROF. WYVILLE THOMSON'S INTRODUCTORY LECTURE AT EDINBURGH UNIVERSITY

(*Continued from page* 76)

THE distinction between inorganic bodies and organised beings instinct with life seems clear enough. Between the animal and the vegetable kingdoms it is impossible to draw a definite line. It is to solve this difficulty that Ernst Haeckel has proposed his fourth kingdom, and we have now to consider whether or not the solution is satisfactory or legitimate.

Plants have the power of secreting and storing in organs which are specially fitted for its reception, usually the leaves, a substance called "chlorophyll," by means of which, acting probably as a ferment or in some way which is not yet thoroughly understood, the plant can, under the influence of light, absorb carbonic acid from the atmosphere, decompose it, and, while the carbon is in the nascent condition, combine it with the elements of water, or with the elements of water and of ammonia, reduced likewise to the nascent state by the same agency. The plant thus gains from the inorganic world, from the water contained in the soil and the inorganic substances dissolved in it, and from the atmosphere, various elementary substances, chiefly, however, oxygen, hydrogen, carbon, and nitrogen, and these it recombines into ternary, quaternary, and still more complex organic compounds.

The operations which take place within the chlorophyll cell of the plant are briefly these:—

1. Water, H_2O, which has been absorbed by the root of the plant from the soil, and pumped up by endosmosis or capillary attraction to the leaf, is decomposed, and its elements are reduced to the nascent condition.

2. Carbonic acid, CO_2, which exists as a gas in the atmosphere to the amount of about 1 vol. to 2,500 of air, and which is consequently in contact with the surface of the leaves, is absorbed, and its elements are reduced to the nascent state.

3. Ammonia, NH_3, an abundant product of the decomposition of organised bodies, which exists in small quantities in the water of the soil, and much more abundantly as a gas in the atmosphere (in the proportion of about 1 vol. to 1,000,000 of air), is decomposed, and its elements are reduced to the nascent state.

4. The nascent carbon of the carbonic acid is combined with the elements of water in varying proportions, and by the re-combination of the elements of these binary compounds, ternary compounds; for example, cellulose, starch, dextrine, and gum, which have all apparently the same composition, $C_6H_{10}O_5$, or some multiple of these proportions; sucrose or cane sugar $C_{12}H_{22}O_{11}$; dextrose and levulose, grape and fruit sugar, $C_6H_{12}O_6$; the glucosides, such as tannine, $C_{27}H_{22}O_{17}$; the fixed and essential oils, some of which latter, however, as turpentine and its isomers, are binary, $C_{10}H_{16}$; and many like substances, are produced.

5. The nascent nitrogen of the ammonia, sulphur, which is probably derived from a trace of sulphuretted hydrogen in the atmosphere; phosphorus, derived from the decomposition of certain minerals contained in the soil or of vegetable or animal matter, are united to form quarternary, quinary, and more complex compounds, such as vegetable albumen, fibrin, casein, and protoplasm.

	Albumen.	Casein.	Fibrin.
Carbon	53·5	53·8	52·7
Hydrogen	7·0	7·2	6·9
Nitrogen	15·5	15·6	15·4
Oxygen	22·0	22·5	23·5
Sulphur	1·6	0·9	1·2
Phosphorus . . .	0·4	0·0	0·3

and the vegetable alkaloids, for example, nicotine $C_{10}H_{14}N_2$, morphine $C_{17}H_{19}NO_3 + H_2O$, and narcotine $C_{22}H_{23}NO_7$. Under the guidance of the vital property, and through the medium of a peculiar substance called protoplasm, whose exact composition it is difficult to determine, but which seems to be closely related to albumen, which is constantly present where vital actions are going on, and in which alone apparently the peculiar property called life resides, these different substances are adjusted as to their related proportions, and selected and applied each to its destined object in the plant economy, to enlarge the cell or to strengthen the cell-wall, to lay the foundation of a new cell, to be stored up in a special reservoir for future use, to contribute, in short, to the development or maintenance of the special specific form of the organism of which it forms a part.